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ABSTRACT

This study examines the rules used by Chinese students to integrate information, and examines the perceived importance of academic ability, effort, and study skills to students and teachers. Information integration theory indicates that individuals use simple algebraic rules (averaging, adding, or multiplying) to integrate information. Cultural background appears to strongly influence the rules used. Six hundred nine Chinese elementary, secondary, and university students, and 102 teachers were asked to predict the academic achievement of hypothetical students using information on academic ability, effort, and study skills. The following findings are presented: (1) younger students used an averaging rule; (2) older students used an adding rule; (3) a multiplying rule was not used at any level; (4) study skills were perceived to be most important by students in grades 3 and 4; (5) effort was perceived to be as important as study skills by intermediate and junior high school students; and (6) ability, effort, and study skills were perceived to be equally important by senior high school students and university students and teachers. The use of the information integration rules by Chinese, American, and Indian students is discussed. A list of 23 references and four tables of statistical data are appended. (FMW)

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Inferences of Academic Performance among Chinese Students: Integration of Ability and Effort Information

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Abstract

Chinese students in Hong Kong were asked to predict the performance of hypothetical students whose ability, effort, and study skill levels were known. The way the given information was used and integrated was examined using the information integration model. In the analyses, the multiplying rule was rejected. Generally an averaging rule was supported among the younger students, and an adding rule was used among the older ones. Older Chinese subjects showed a strong belief that effort always added to performance irrespective of the ability level. The findings were discussed in terms of the socialization patterns in the Chinese culture.

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Inferences of Academic Performance among Chinese Students: Integration of Ability and Effort Information

In the present study, information on the ability, effort, and study skill levels of hypothetical students were given. Chinese subjects were asked to predict the students' academic performance. The way the information was used and integrated, as well as the relative importance of ability, effort, study skill were examined using a mathematical model.

It has been shown experimentally that a lot of psychological tasks to integrate information obey simple algebraic rules. The study of these processes is collectively know as the information integration theory (Anderson, 1981, 1982). The present study will examine three common rules, namely, adding (Performance = Ability + Effort), multiplying (Performance = Ability X Effort), and averaging [Performance = (w_EEffort + w_AAbility)/ (w_E + w_A)](for details of different rules see Anderson, 1981, 1982).

The validity of the adding rule can be examined using the parallelism test -- a set of parallel curves in the two-way plot of the observed response. It is equivalent to a zero (nonsignificant) interaction term in the analysis of variance. If multiplying rule is being used, a factorial plot of the observed response matrix will display a fan of

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straight lines, but there should be crossover interactions between trials with different number of factors. The latter test helps to distinguish the multiplying rule from the averaging one.

In the averaging rule, each stimulus has two-parameters, the scale value, and a weight w. The weights correspond to the relative importance of the stimulus in regard to the production of the response. For averaging model with constant weighting, parallelism will apply. A critical test between adding and averaging is the addition of a 'none' curve (no information on other factors) in the factorial plot. This added curve will be parallel to the other curves if adding rule is used, whereas a crossing over will support an averaging rule.

Psychological Significance of Different Rules

Subjects using a simple adding rule believe that effort would be equally effective with people of low or high ability. However, those using multiplying rule think that effort will greatly improve performance only for high ability people. In other words, people of lower ability gain less by trying.

An averaging model differs from an adding one in that in the former the sum of all weights is equal to unity. An averaging rule also predicts that an added moderate positive information will average out an already very positive information (e.g., the additional information 'moderately

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high effort' decreases the performance rating of a student already described as 'very high ability').

Developmental and Cross-Cultural Differences

Integration models are particular useful in developmental and cross-cultural studies because they concentrate on the patterns of responses rather than on their absolute numerical values, no assumption has to be made about the equivalence in the values of specific stimuli. Surber criticized that 'this [scaling issue] is a fundamental problem in the study of development that is more often avoided than confronted' (1984, p.227).

Heider's hypothesis, performance = motivation X ability, has been examined for the American subjects using an information integration model (Anderson & Butzin, 1974). Generally, the multiplying rule was supported.

In Kun, Parson and Ruble's (1974) study, children (age 6-11) and adults were asked to predict the performance of hypothetical students whose effort and ability levels were given. Results showed an adding rule among the youngest groups and a multiplying rule among the adults.

In a series of three experiments to validate the previous U.S.A. findings, Singh, Gupta, and Dalal (1979) found that the Performance = Motivation X Ability multiplying rule failed to appear with the Indians. In their study, Indian college students were asked to predict the performance of hypothetical students whose interest in

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study (motivation) and IQ (ability) levels were known. Their results rejected the adding rule and supported an averaging one. The findings were replicated in another similar study (Gupta & Singh, 1981) using students (age 6 to 13) and adults in Indian.

Singh et al. argued that the averaging rule reflected the more egalitarian outlook of the influence of ability among the Indians, which was an healthy sign for progress in India. People, regardless of their original ability, had equal opportunity to improve. Singh et al. believed that the integration rule might be culture specific. As subjects in previous studies were mainly university students, Singh et al. recommended that more diversified subjects from different educational or cultural strata should be used.

Surber (1980) suggested that the above studies (Anderson & Butzin, 1974; Kun et al., 1974) did not distinguish the multiplying from the averaging rules. Furthermore, Surber challenged that Anderson and Butzin's (1974) finding of the multiplying rule was a result of the nonlinearity of the response scale as well as a developmental change in the use of the response scale, rather than in the way the ability and effort information were combined. In a number of studies (Surber, 1980, 1981a, 1981b, 1985) showed that averaging model could best account for the data for different tasks and at different age levels. Age-related differences in prediction of

performance was explained by the change in weights with the scale values.

To clarify previous cross-cultur dings of parallelism pattern in Motivation X Ability, and to examine the possible influence due to task difficulty level, Singh and Bhargava (1985) replicated previous researches with Indian students. They found that the adding rule was sustained in both student and non-student Indian population, and among easy and difficult task.

Srivastava and Singh (1988) also attempted a series of studies to examine whether the nature of the task and the age of subjects might change the utilization of different integration rules. Individual level analyses revealed a U-shaped curve in the use of integration rule: 4-5-year-olds in a transition from adding to multiplying-type, 6-9-year-olds using multiplying rule, 10-12-year-olds reverting to adding from the multiplying rule, and adolescence using adding rule all together.

The results of both studies by Singh and Bhargava (1985), and by Srivastava and Singh (1988) were explained in terms of cultural differences in that the Americans were more individualistic whereas Indians were collectivistic. The multiplying rule was reflective of the elitist and egalitarian view of the American and Indian value system respectively. The results further showed that Indians had the capability to use the multiplying rule in predict

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performance. However, as suggested by Srivastava and Singh (1988), Indians reverted to adding rule because of their tendency to conform with the idealistic egalitarian belief which was prevalent in Indian society.

In the present study, a few common integration rules were considered, which were namely, adding, multiplying and averaging. In view of findings showing that Chinese child rearing and education were generally quite harsh and authoritarian and that diligence was a highly praised virtue (Hau & Salili, 1990; Hess, Chang, & McDevitt, 1987; Ho, 1986), it was hypothesized that Chinese students would have a more egalitarian view of effort and ability in determination of success. Adding and averaging rules were expected but not the multiplying ones.

Method

Subjects

The subjects were 609 Chinese students and 102 teachers in Hong Kong. The number of students in G.1/2, G.3/4, G.5/6, G.7/8, G.9/10, G.11/12, and university were 61, 65, 75, 112, 118, 81, and 97 respectively.

Procedure

The method as used by Surber (1985) was adopted. Subjects were given information on the ability (e.g., very high ability), effort, study skill levels of a student. There were totally 99 hypothetical situations, with combinations of different ability, effort, and skill levels.

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Subjects were asked to predict the achievement level of that particular student on a 9-point scale (very good to very bad).

Results

Initial Model Evaluation

An inspection of the *F*-values of different subdesigns of Education X Ability X Effort X Study Skill showed strong main effects and relatively small interactions. Two-way plots of Ability X Effort, Ability X Skill, and Effort X Skill for different educational levels showed that the adding or averaging rules were generally supported, whereas the multiplying one was not.

The multiplying rule predicted that the interaction term in the two-way factorial designs should be significant, and should be concentrated in the Linear X Linear (bilinear) component. In the present study, the interactions and the residual terms were calculated by the FM#1 subroutine (option 8) (Shanteau, 1977; Weiss & Shanteau, 1982).

As can be seen from the *F*-values of interactions and the variance components, the interaction terms were generally relatively small, most of them were less than 3% of the main effects. Moreover, when the two-way interactions were significant, it was found that either the bilinear terms were not significant, or the interactions resided in other higher order terms as well. Thus, multiplying rules were generally not supported.

In conclusion, the above analyses generally supported either the averaging or adding rules and rejected the

multiplying one. Thus, the following tests would concentrate on distinguishing adding from the averaging rules.

Set-Size Effect

The mean judgment of the performance as a function of different experimental subdesigns and different educational levels were calculated. The averaging rule predicted that the effect of a factor (e.g., ability) would be the largest when presented alone, and least when combined with the other two factors (e.g., effort and study skill). On the other hand, multiplying or adding rules predicted that the lines of different subdesigns would be parallel.

The analyses of the effects of each factor (ability, effort and skill) individually showed that among the younger age groups, the effect of the factor was stronger when presented alone, but became the smallest when presented with the two other factors. Thus, the results suggested an averaging rule and rejected the adding one among the younger students.

Addition of 'None' curves

Lines of 'none' curves consisting of information of one factor only (e.g., ability) were added to the Ability X Effort, Ability X Skill, and Effort X Skill plots. Generally, these added lines crossed over the existing lines in the younger age groups, which supported an averaging rule. On the other hand, the added lines were parallel to the original lines in the older age groups, which supported an adding rule.

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Parameters in Averaging Model

The scale values and weights of the three factors (i.e., ability, effort, and study skill) in the averaging model were estimated with the STEPIT subroutine (Chandler, 1969). Separate analyses were repeated for i. all subjects, ii. the eight educational levels, and iii. each sex in the eight educational levels. The 99 mean judgments were fitted to the averaging model, and solution were obtained by minimization of the sum of the squared deviations between the model predictions and the means.

As the scale values were estimated for each age group separately, strict comparisons of the weights across the groups were not appropriate (Surber, 1982). Nevertheless, it was still informative to see how the weights changed across the educational levels.

A comparison of the weights within the same educational level showed that for the older age groups (G. 9 and above), the weights of ability, effort, and study skill were approximately the same (see Table 1). For the G.3/4 group, the weight of study skill was larger than those of effort and ability, while the values of the latter two were approximately the same. For the G.5/6 and G.7/8 groups, effort became as important as study skill, and these two were more important than ability.

Insert Table 1 here

Individual Level Analyses

Group average analyses might not reflect the integration model at individual level. It was warned (Anderson & Butzin, 1978; Surber, 1984) that group means might not reflect actual models in individuals. For example, a subject with heavy weight on ability when combined with one with heavy weight on effort would generate a resultant moderate weight on both factors. It was possible that individuals who concentrated on different stimuli (or opposite stimuli) when combined together may display patterns not reflecting individual's responses.

In this study, individual data was fitted to the averaging model using the subroutine STEPIT. The method as used by Surber (1985) was adopted. Weights and scale values were obtained for each individual subject. The weights of the three factors were compared, and Table 2 shows the number of subjects in each possible ordering of the weights; $X^2(35) = 70.12$, $p < .001$.

Insert Table 2 here

A difference of .1 in weights was arbitrarily adopted as the criterion in the comparison of weights. A subject was classified as 'ability' dominated if his/her weight in ability was at least .1 larger than the weights in effort and study skill. A subject was said to be 'Ability + Effort' dominated if these two weights were both at least .1 greater than the weight in study skill (but weights in ability and effort did not differ by more than .1).

Subjects not falling into any of these categories were unclassified. The result of this grouping process was shown in Table 3; $X^2(42) = 111.28$, $p < .001$. Generally, more older students could be categorized into single factor dominant (i.e. A, E, or S only). Older subjects were more aware of their main concern (e.g. ability) when making their judgment of performance, and they were more consistent in the application of their judgment rules.

Insert Table 3 here

The mean of the weights were shown in Table 4. Both absolute ($w_0 = 1$) and relative weights ($w_A + w_E + w_S + w_0 = 1$) were displayed. A two-way 8 Educational level (between-subject) X 3 Weight (within-subject) ANOVA of the absolute weights showed significant main and interactional effects; for educational level, $F(7, 769) = 13.90$, for weight, $F(2, 768) = 15.40$, for interaction, $F(14, 1534) = 7.20$, all $p < .001$. The weights in Tables 4 showed that study skill was an important factor among younger primary school students, but it was gradually less important among senior high school students. Study skill became important again among university students and teachers. There was a slight tendency that older primary schools and junior high school students gave heavier weights to effort than other educational groups.

Insert Table 4 here

Conclusion and Discussion

The multiplying rule was rejected on several grounds -- visual inspection of two-way plots, nonsignificant interaction terms in two-way ANOVAs, small bilinear term in component analyses.

The other analyses to distinguish averaging and adding rules showed that generally an averaging rule was supported among the younger students, and an adding rule was used among the older ones.

A comparison of the weights in the averaging model revealed that study skill were more important than effort and ability among the G.3/4 students. For the older senior primary school and junior high school students, effort became as important as study skill, which were both more important than ability. For senior high school, university students and teachers, the weights of ability, effort and study skill were approximately equal.

For senior high school, university students, and teachers, an adding rule was adopted. They believed that effort, ability, and study skill each individually added to the performance irrespective of the weakness (or strength) of the other factors. On the other hand, an averaging rule dominated among the younger students.

There were still debate on whether Americans should be characterized as multiplying or averaging oriented, and it was difficult to draw definite conclusion at this stage. Nevertheless, it should be noted that in the present study

the multiplying rule was rejected at all educational levels. This was contradictory to the results with the U.S.A. subjects in Anderson and Butzin's (1974) and Kun et al.'s (1974) studies. However, the results with the Chinese in Hong Kong showed good resemblance with those found with Indians (Singh et al., 1979; Singh & Bhargava, 1985; Srivastava & Singh, 1988).

Noteworthily, in Srivastava and Singh's (1988) study with Indians, older children (age 10-12) and adolescence reverted to the use of adding rules (from multiplying rule). In the present study with Chinese, it was found that older children, university students and teachers tended to use adding rules. As younger groups already showed the ability to use the more sophisticated averaging rule, the use of the simple adding rule in older subjects could not be due to cognitive constraint.

The multiplying rule predicted that the effect of effort was smaller when the ability was low, whereas the averaging rule predicted that effect of effort diminished when the ability was extremely high. Both phenomena were not observed in the older Chinese groups. Rather, subjects in the present study showed a strong belief that effort always added to performance irrespective of the ability level. These findings were in congruence with the results in other research (Hau & Salili, 1990, in press) which showed that Chinese students emphasized effort and were learning oriented.

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Table 1

Scale Values of Ability, Effort and Study Skill in the Averaging Model

	Scale Value				
Subjects	V.Low	Low	High	V.High	Range
			Ability		
All Subjects	.50	1.32	11.28	12.58	12.08
G.1/2	1.55	2.52	10.06	10.97	9.42
G.3/4	1.38	2.21	9.63	10.55	9.17
G.5/6	1.75	2.16	9.93	10.87	9.12
G.7/8	.95	1.62	11.74	13.63	12.68
G.9/10	.04	.68	12.89	14.60	14.56
G.11/12	-.45	.51	13.85	16.36	16.81
University	-1.33	-.20	13.58	14.86	16.19
Teachers	-2.18	-.70	13.98	15.52	17.70
			Effort		
All Subjects	-.33	.67	10.70	11.88	12.21
G.1/2	.62	1.90	9.83	10.84	10.22
G.3/4	.60	1.47	10.15	11.36	10.76
G.5/6	.57	1.31	9.27	10.03	9.46
G.7/8	.15	1.09	10.52	11.61	11.46
G.9/10	-1.37	-.54	12.04	13.37	14.74
G.11/12	-.87	.17	11.46	13.07	13.94
University	-1.95	-.82	12.99	14.63	16.58
Teachers	-2.23	-.61	12.18	13.57	15.80
			Study Skill		
All Subjects	1.47	6.05	10.46		8.99
G.1/2	1.47	5.35	10.08		8.61
G.3/4	1.94	5.95	9.66		7.72
G.5/6	1.73	5.42	9.08		7.35
G.7/8	1.95	6.16	9.63		7.68
G.9/10	.85	6.77	11.66		10.81
G.11/12	1.08	6.99	12.82		11.74
University	.51	6.65	13.08		12.57
Teachers	.46	6.37	12.29		11.83

Table 2

Percentage of Students With Different Order of Weights in Averaging Model

Edu. level	Order of Weights[a]						
	A>E>S	A>S>E	S>A>E	E>A>S	E>S>A	S>E>A	total
G.1/2	6.6 (4)	13.1 (8)	27.9 (17)	13.1 (8)	14.8 (9)	24.6 (15)	100 (61)
G.3/4	7.6 (5)	19. (13)	19.7 (13)	6.1 (4)	12.1 (8)	34.8 (23)	100 (66)
G.5/6	8.0 (6)	9.3 (7)	21.3 (16)	13.3 (10)	18.7 (14)	29.3 (22)	100 (75)
G.7/8	11.6 (13)	6.3 (7)	16.1 (18)	13.4 (15)	23.2 (26)	29.5 (33)	100 (112)
G.9/10	15.1 (18)	11.8 (14)	14.3 (17)	15.1 (18)	24.4 (29)	19.3 (23)	100 (119)
G.11/12	21.0 (17)	12.3 (10)	12.3 (10)	14.8 (12)	14.8 (12)	24.7 (20)	100 (81)
Univ.	19.0 (24)	19.8 (25)	16.7 (21)	18.3 (23)	11.9 (15)	14.3 (18)	100 (126)
Teach.	24.8 (34)	16.1 (22)	16.1 (22)	13.1 (18)	10.2 (14)	19.7 (27)	100 (137)
Total	15.6 (121)	13.6 (106)	17.2 (134)	13.9 (108)	16.3 (127)	23.3 (181)	100.0 (777)

Note. Actual number of students in brackets.

[a] A>E>S = $W_A > W_E > W_S$.

Table 3

Percentage of Students with Different Dominant Types in Averaging model

Edu Level	Dominant Characteristics (%) A	E	S	A+E	A+S	E+S	Non-class	Total
G.1/2	24.6 (15)	4.9 (3)	8.2 (5)	32.8 (20)	9.8 (6)	11.5 (7)	8.2 (5)	100 (61)
G.3/4	27.3 (18)	12.1 (8)	9.1 (6)	34.8 (23)	0.0 (0)	10.6 (7)	6.1 (4)	100 (66)
G.5/6	14.7 (11)	6.7 (5)	22.7 (17)	38.7 (29)	5.3 (4)	2.7 (2)	9.3 (7)	100 (75)
G.7/8	23.2 (26)	7.1 (8)	19.6 (22)	29.5 (33)	3.6 (4)	4.5 (5)	12.5 (14)	100 (112)
G.9/10	21.0 (25)	11.8 (14)	25.2 (30)	15.1 (18)	3.4 (4)	9.2 (11)	14.3 (17)	100 (119)
G.11/12	25.9 (21)	13.6 (11)	21.0 (17)	18.5 (15)	7.4 (6)	9.9 (8)	3.7 (3)	100 (81)
Univ	17.5 (22)	23.0 (29)	12.7 (16)	23.0 (29)	9.5 (12)	7.1 (9)	7.1 (9)	100 (126)
Teach	20.4 (28)	29.2 (40)	8.0 (11)	19.0 (26)	9.5 (13)	6.6 (9)	7.3 (10)	100 (137)
Total	21.4 (166)	15.2 (118)	16.0 (124)	24.8 (193)	6.3 (49)	7.5 (58)	8.9 (69)	100 (777)

Note. Actual number of students in brackets.

Table 4

Individual Analyses: Mean Weights of Ability, Effort, and Study Skill in Different Educational Level

	Absolute Weight[a]				Relative Weight[b]		
Edu Level	Ability	Effort	Study Skill	*F*	Ability	Effort	Study Skill
G.1/2	.60	.57	.70	3.83*	.19	.19	.24
G.3/4	.51	.48	.63	16.80***	.18	.17	.22
G.5/6	.42	.58	.63	15.81***	.15	.21	.22
G.7/8	.32	.43	.44	12.21***	.13	.18	.18
G.9/10	.37	.47	.43	6.37**	.16	.20	.18
G.11/12	.33	.37	.34	.74	.15	.17	.15
Univ.	.51	.44	.46	4.06*	.20	.17	.18
Teachers	.57	.51	.52	3.66*	.21	.19	.19
Total	.45	.47	.50		.17	.18	.19

[a] w_A, w_E, w_S.

[b] $w_A/(w_A + w_E + w_S)$, $w_E/(w_A + w_E + w_S)$, $w_S/(w_A + w_E + w_S)$.

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